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ABSTRACT

A study of the effectiveness of formative evaluation and remediation activities in achievement of intellectual skills was made, involving a general science teacher and his four classes of 90 eighth grade students. Subjects were ranked by using the Arithmetic Skill Test of the Iowa Tests of Basic Skills and randomly assigned into three treatment groups. Each group was further divided into seven levels of the classification variable. All subjects were first presented a tape-slide instructional program and then took a diagnostic test. The remedial activity materials were delivered in the following day. Group 1 received an alternative form of instruction designed to teach similar objectives, while group 2 received additional practice items. No additional instruction was given to group 3. A 13-item measuring instrument was used. Analyses showed that, in remediation of learning errors, the alternative form of instruction was proved more effective than the use of additional practice items, agreeing with Gagne's hypothesis. Group 1 and group 2 achieved better than did group 3. Diagnostic tests were proved important in the production of higher student performance. Implications for classroom teachers and curriculum designers are provided. (CC)

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An Investigation of the Effectiveness of Formative Evaluation and Remediation in Achieving Mastery of Intellectual Skills*

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Bloom (1968) suggested that all, or almost all, students can master what they are taught. The use of mastery learning strategies should enable 75 to 90 percent of the students to achieve the same high level as the top third of those presently learning under traditional group-based instructional strategies. One of the strategies associated with mastery learning is for the instruction to contain frequent formative evaluation and remediation activities. If the student has not been successful in achieving mastery, then areas of weakness need to be identified and additional instructional pathways presented. This investigation was an attempt to identify some instructional strategies which may be effective in remediating detected learning errors.

Recent research on mastery learning offers some empirical support for the strategy of frequent formative evaluation and remediation. Experimental studies (Collins, 1971; Merrill, Barton, & Wood, 1970; Neal & Foster, 1928) employing formative evaluation and remediation strategies yielded data indicating that the majority of students in each study were able to perform at the mastery level.

However, other research on mastery learning does not offer support for the strategy of frequent formative evaluation and remediation. Experimental studies (Lawler, 1971; Merrill, 1965; Okey, Brown, & Fiel, 1972) employing formative evaluation and remediation strategies yielded data which failed to support the hypothesis.

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Closer examination of these studies suggests that the success or failure of a specific remediation strategy may depend upon the form the remediation takes. For the most part, those studies that produced significant improvement employed an alternative form of instruction (attending to prerequisites) as remediation and those studies which failed to produce significant improvement employed additional practice (more of the same) remediation.

Gagne (1971) suggests that different parts of a content area may require different instructional strategies, different content areas may require similar instructional strategies, and different assessment techniques may be required for different kinds of learning. He defines five domains (or types) of learnings: motor skills, verbal knowledge, intellectual skills, cognitive strategies, and attitudes; and suggests instructional strategies and assessment techniques appropriate for each domain. If the hypotheses of Gagne are correct, matching the remedial instruction strategy with the domain of learning involved should produce significant improvement in achievement.

Of particular interest to this investigation was Gagne's proposal that the learning of intellectual skills requires prior learning of prerequisite tasks and that attention to prerequisites should be more effective than repeated practice of the task, a procedure recommended for learning motor skills.

The purpose of this investigation was to determine if an alternative form of instruction used as remediation would produce a more significant improvement in achievement of intellectual skills than additional practice items used as remediation.

Population and Procedure

The subjects involved in this investigation consisted of 90 eighth-grade general science students who were members of four different classes taught by the same instructor.

The subjects were ranked on the basis of their total score on the Arithmetic Skills Test of the Iowa Tests of Basic Skills. Random assignment within triads of the subjects produced three treatment groups of 30 subjects each. In addition to being assigned to a treatment group, each subject was also assigned to a level of the classification variable (Arithmetic Skills Test Score). The purpose of using the classification variable as a blocking variable was to increase the precision of the experiment (Feldt, 1958).

After examining the tabled values for the optimal number of levels for a classification variable when used in blocking for precision, each treatment group (N=30) was divided into seven levels, six levels of four subjects each and one level of six.

All classroom activities during the investigation were directed by the regular classroom teacher. In introducing the activities, the teacher explained that he was interested in trying out a different form of instruction. The general form of the instruction was explained and the students told that they would be graded on their performance in the final examination covering the instruction.

Each subject studied a block of self-instructional material on identifying variables, constructing graphs, and interpreting graphs. The instructional materials were designed to teach each of the tasks in a learning hierarchy, consisting of a terminal task and 13 subordinate skills (Okey, 1971).

The first two days of classroom activities consisted of a laboratory exercise and self-instructional material. This time was used to acclimate the subjects to self-instructional materials and diagnostic testing; consequently, no data were collected during this period.

Actual experimental treatment began on the third day. All subjects were presented a tape-slide program on constructing a table of data. At the end of the presentation the subjects took a diagnostic test covering the objectives of the instruction. At the end of the day the investigator collected the diagnostic tests from the classroom

teacher, graded each, and assembled and delivered the remedial activity materials to the teacher in time for the next day's classes.

The results of the diagnostic tests were used to indicate which skills each subject had not acquired from the main-line instruction. Subjects in Group 1 and 2 who were not successful on a particular test item received remedial activities. Group 1 received an alternative form of instruction designed to teach the same objectives as the main-line instruction. Group 2 subjects received additional practice items very similar to those in main-line instruction. Subjects in Group 3 received no additional instruction. All remedial activities were paper and pencil programs in which the subject responded to a problem and received immediate feedback.

This instruction-diagnostic test-remedial activity sequence was repeated three times during the investigation. The criterion measure, consisting of thirteen items covering the terminal task and twelve of the subordinate skills and requiring 40 minutes to complete, was administered to all subjects on the day following the third remedial period.

Results

The criterion measure scores in a randomized block design involving 3 levels of the treatment variable and 7 levels of the classification variable were analyzed by factorial analysis of variance. A priori comparisons among the treatment means were tested by partitioning the treatment sum of squares into orthogonal contrasts. Comparison 1 was between those subjects receiving remediation and those receiving no remediation. Comparison 2 was between those subjects receiving additional practice remediation and those receiving alternative instruction remediation.

Table 1. Partitioning of the Treatment Sum of Squares by Orthogonal Contrasts.

Sources of Variation	Degrees of Freedom	Sums of Squares	Mean Squares	F Ratios
Treatment	2	55.756		
Comparison				
1	1	32.938	32.938	5.818*
2	1	22.815	22.815	4.030*
Remainder	18	552.567		
Error	69	390.667	5.662	
Total	89	998.989		

*p<0.05

It was concluded that there was a significant improvement in scores attained on the criterion measure which could be attributed to the use of remedial activities as well as a significant improvement which could be attributed to the use of an alternative form of instruction.

Discussion

In this investigation it was found that the use of an alternative form of instruction in an attempt to remediate learning errors produced a more significant improvement in achievement of intellectual skills than did the use of additional practice items as remediation.

The hypothesis that identifying learning problems and providing additional instruction will improve performance was supported. Students who received both kinds of remedial instruction did significantly better than those receiving only main-line instruction. This implies that a teacher interested in having his students be successful in cognitive activities should identify learning errors and provide some sort of remedial activity.

The results also support the hypothesis that some types of remedial activity may be more effective than others for certain kinds of learning outcomes. Students receiving an alternative form of instruction did significantly better than those receiving additional practice items as remediation. The results support Gagne's hypothesis that learning intellectual skills requires the mastery of prerequisite tasks and that additional study on the prerequisite tasks of intellectual skills will be more effective in remediating errors than additional practice of those skills.

These findings have direct and important implications for classroom teachers and curriculum developers. It has been common practice in situations where the teacher or the curriculum materials provide remedial activity for students who have demonstrated learning errors to offer them additional practice or to recycle them through the main-line instruction. According to the findings in this investigation these strategies may not be maximally effective in improving performance. It would seem more appropriate to provide an alternative form of instruction in attempting to remediate learning errors. A teacher attempting to individualize instruction in his classroom may produce higher student performance in learning intellectual skills if he selects prepared curriculum materials that contain diagnostic tests and provides the student with alternative instructional pathways or if he diagnostically tests his students and selects alternative instruction to remediate detected errors in learning intellectual skills.

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